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11 DECEMBER 1989



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# **China**

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## ***SCIENCE AND TECHNOLOGY***

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# Science & Technology CHINA

JPRS-CST-89-026

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**'Fengyun 1' Meteorological Satellite Detailed**  
*90CF0030A Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS]*  
*in Chinese No 3, Jul 89 pp 1-9*

[Article by Meng Zhizhong [1322 2304 0022] and He Zhenghua [0149 2973 5478], Shanghai Institute of Spacecraft Engineering; revised manuscript received 16 Apr 89]

[Text] Abstract:

This article gives a description of China's first meteorological satellite, the "Fengyun 1." This 750-kg experimental satellite has a hexagonal main body whose dimensions are 1.40m x 1.40m x 1.20m; the overall length including the solar-cell panels is 8.60m and the height is 1.76m. The satellite is in a 900-km sun-synchronous orbit with an inclination of 99°; it revolves around the earth 14 times per day. The satellite's mission is to transmit high-quality pictures from space and information on the space radiation environment to the ground.

**I. Introduction**

The first Chinese experimental meteorological satellite, the "Fengyun 1" (FY-1), was launched on 7 September 1988. The satellite is in a sun-synchronous orbit, revolving around the earth 14 times a day; it is designed to transmit high-quality pictures and information on the space radiation environment to the ground. The main objectives of the FY-1 are to test and evaluate the performance of the on-board instruments and equipment and the design technology in order to provide useful data for the development of future meteorological satellites and for other applications.

One of the primary design considerations for the FY-1 was to provide service for the entire world population, particularly for the developing countries. At present, over 30 countries own more than 80 S-band high-resolution real-time [transmission] (HRPT) receiving stations; over 120 countries, primarily developing countries, own more than 1,000 inexpensive but effective VHF real-time [automatic] picture [transmission] (APT) receiving stations. For this reason, our satellite is equipped with not only HRPT channels but also APT channels. To facilitate picture reception by the user, both APT and HRPT channels are designed to have high signal strength, and the transmission band, the modulation and the signal format are designed to be compatible with those of the U.S. meteorological satellite, the TIROS-N/NOAA.

The external configuration of the FY-1 satellite is shown in Fig. 1 and Fig. 2, and the overall performance data are presented in Table 1. FY-1 has a hexagonal main body whose dimensions are 1.40m x 1.40m x 1.20m; the body is covered with a layer of insulating material for thermal control. The transmission system consists of an antenna group with a common reflecting plate, an infrared horizon sensor, and two scanning radiometers, one of

which is a back-up. The infrared horizon sensors are cooled to an operating temperature of 105 K by pointing the cooling unit of the radiometer toward space. On each side of the main body are solar-cell panels and a support panel. In order to ensure high picture quality, the satellite is placed in a near-polar sun-synchronous orbit. The orbital plane regresses from east to west, which is opposite to the direction of earth rotation; the variations of the orbital plane and the angle between the solar panel and the sun-ray vector are less than plus or minus 10°. The local time at which the satellite passes any region on earth remains almost constant. To achieve these goals, the satellite launch trajectory must be very accurate, and the launch window must be carefully selected.

**Table 1. Overall Performance Data**

Sun-synchronous orbit	
Perigee	891.1 km
Apogee	925.4 km
Inclination	99.1°
Period	102.8 min.
Eccentricity	0.0023
No. of orbits per day	14
Satellite mass	750 kg
Which contains:	
Nitrogen	(12 kg)
Payload	(340 kg)
Scanning radiometers	(273 kg)
Cosmic ray monitor	(3 kg)
Picture transmission	(64 kg)
External dimensions	
Main body	1.40m x 1.40m x 1.20m, hexagonal
Maximum height	1.76m
Total length [incl. solar array]	8.60m
Solar-cell array	6 panels, each 1.20m x 0.955m
Power supply	
Silicon solar-cell array	14,256 cells, each 2cm x 2cm
Solar-cell array output	830 watts
Regulated power output	300 watts
Scanning radiometers	2
Resolution	1.1 km for digital images (satellite sub-point, 900 km orbital height); 4.0 km for analog images (linearly homogenized)
Five channels	0.58-0.68 micron
	0.725-1.10 microns
	0.48-0.53 micron
	0.53-0.58 micron
	10.5-12.5 microns
Cosmic ray monitor	Detects He, H, C, N, O, Fe particles
Data transmission	

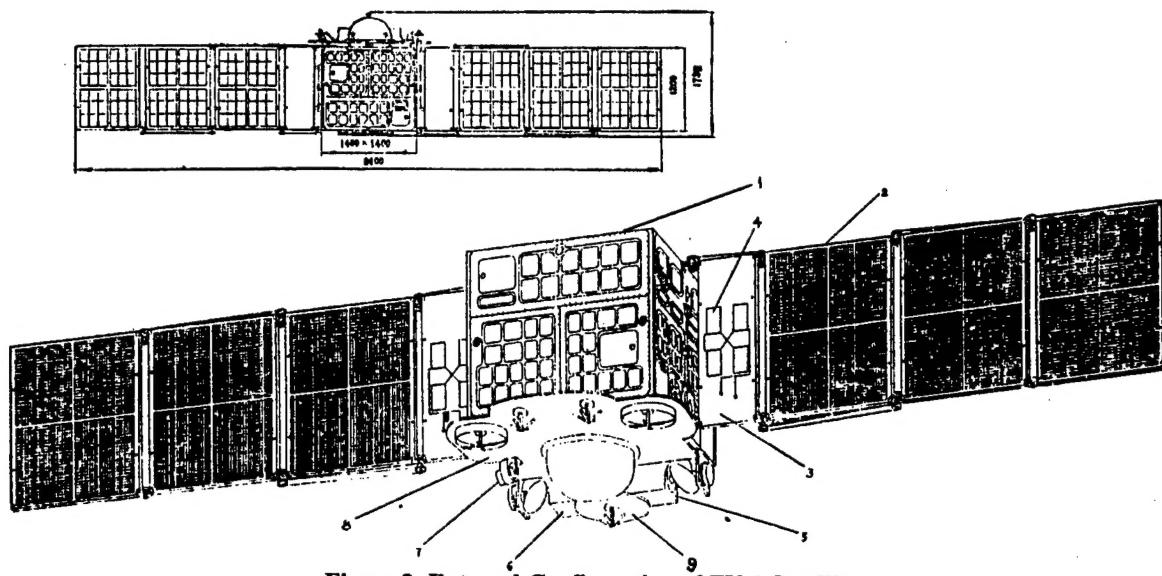
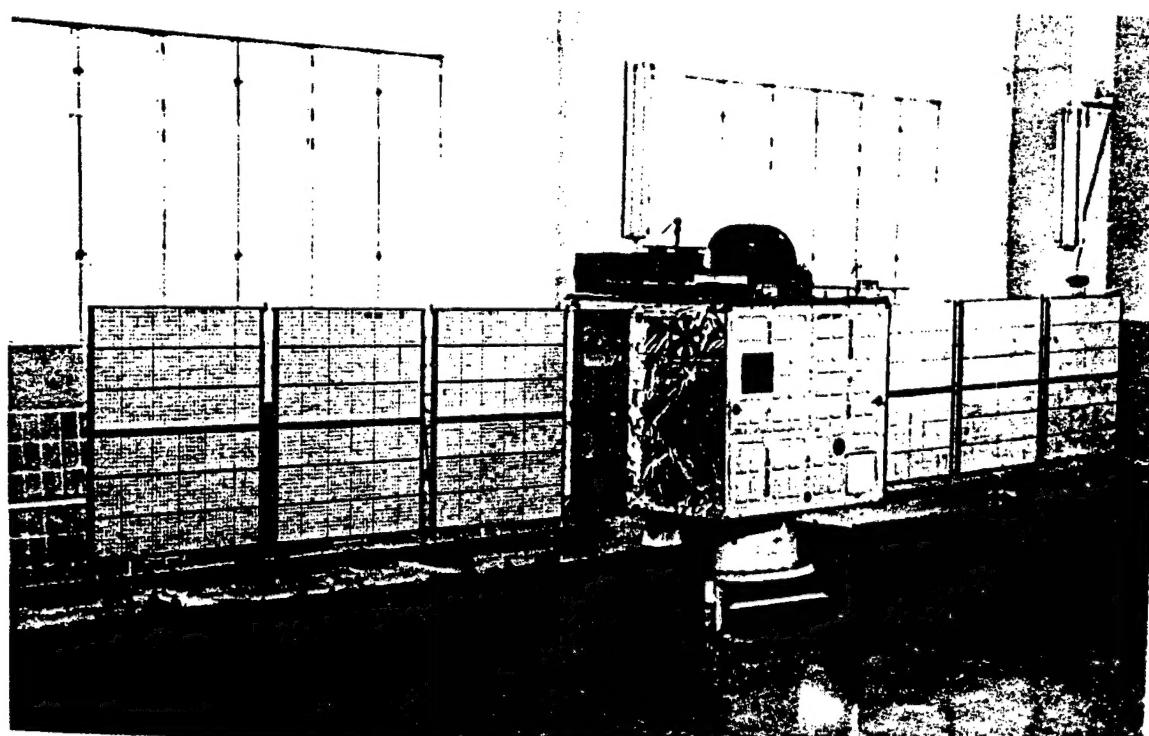


Figure 2. External Configuration of FY-1 Satellite

Key: 1. Main body. 2. Solar-cell panels. 3. Support panels. 4. Power dissipator. 5,6. Scanning radiometers. 7. Infrared horizon sensor. 8. Antenna group and common reflecting plate. 9. Antenna



Overall View of FY-1 Satellite [photo from back cover of SHIJIE DAODAN YU HANGTIAN (MISSILES &amp; SPACECRAFT), No 132, Apr 89]

**Table 1. Overall Performance Data (Continued)**

HRPT	S-band
APT	
VHF band	
DPT [delayed picture trans.]	UHF band
Attitude control	3-axis attitude stabilization
Earth-pointing accuracy	Less than 0.5° in pitch and roll, less than 1° in yaw
Drift rate	0.005°/sec. (3-axis)
Thermal control	Primarily passive control, with temperature equalization and local temp. control
Launch Vehicle	Long March 4 rocket
Onboard units and parts	45 units, 77 parts

Each scanning radiometer has four channels in the visible-light region and one channel in the infrared region. The two channels in the 0.58-0.68-micron and 0.725-1.10-micron bands are used to correct images of clouds, the ground surface and the ocean surface from sun reflections during daytime. The 10.5-12.5-micron infrared channel is used to collect an object's own radiation during both daytime and nighttime; this data can be processed to provide temperatures of the cloud layer and the earth surface. The 0.48-0.53-micron channel and the 0.53-0.58-micron channel are primarily used to measure water color, the silt content and the chlorophyll content of the ocean; they can also be used to monitor the growth of crops and forests. The three-axis attitude-control subsystem is designed to keep the remote sensors and the antenna accurately pointed at the satellite subpoint on the ground, and to maintain a stable attitude oriented toward the earth. The digitized HRPT signals are transmitted in real time via an S-band carrier with a subpoint resolution of 1.1 km and the linearly homogenized analog APT signals are transmitted in the VHF band with a resolution of 4 km; they can be received by users around the globe. The onboard magnetic tape recorder records the analog image of a particular region according to a specified procedure. When the satellite enters the coverage zone of one of China's three main receiving stations, the UHF-band delayed picture transmission (DPT) is activated. These three main stations are located in Beijing, Guangzhou and Urumqi respectively; their total coverage includes the Chinese territory as well as the air space extending beyond the Chinese border. The DPT channels can be used to collect global weather data as well as land and ocean information for atmospheric science and for improving the accuracy of long-range weather forecasts; they can also provide meteorological and oceanic data to promote international cooperation and technical exchange.

## II. The Satellite

The satellite has seven subsystems: the structure subsystem, the power-supply subsystem, the thermal-control subsystem, the attitude-control subsystem, the remote-sensing

and environment-monitoring subsystem, the picture-transmission subsystem and the telemetry-and-control subsystem. The "Fengyun 1" satellite, including all parts and materials and the onboard instruments and equipment, was designed and built totally in this country.

### 1. Structure Subsystem

The structure subsystem consists of five sections: the main-body housing, the instrument panel, the support cylinder and support cone, the cover skin for the housing, and the rocket-interface segment and solar array structure, as shown in Fig. 3 and Fig. 4. [not reproduced] The solar-array structure includes the base plate, the support plate, the locking mechanism and the deploying mechanism. On each side of the structure perpendicular to the satellite motion, there are one support plate and three base plates. With the solar array in its extended position, the satellite measures 8.60m in length and 0.955m in height. The base plate, the support plate, and the common reflecting plate of the antenna group are made of a carbon-fiber aluminum honey-comb structure.

### 2. Power-Supply Subsystem

The power-supply subsystem consists of the solar-cell array, the nickel-cadmium batteries, the voltage regulator and the power dissipator. The solar array contains 14,256 2cm x 2cm silicon cells which are attached to six base plates. The single-cell efficiency at 25°C is greater than 12 percent, which is in compliance with AMO standards. The maximum output power is 830 watts. The effective power output of the voltage regulator is 300 watts. The maximum load of the satellite is 270 watts and the average load between night and day is 250 watts. During the orbital segment when the solar angle is small, the output power will exceed demand; the excess power is dissipated into space by the power dissipator. During the orbital segment when the satellite is in earth's shadow, power for satellite operations is provided by the nickel-cadmium batteries.

### 3. Thermal-Control Subsystem

Thermal control is accomplished by a mixed approach of temperature equalization and local temperature control. The primary approach is passive temperature control, where multiple layers of aluminum-foil insulation are used to cover the main body. The interior surface of the main body and all the units and parts inside the satellite are either coated with high-emissivity black paint or anodized to provide a black surface. Two temperature-control rotating disks, installed on each side where the solar panel is attached, automatically adjust the heat dissipating surface. The instrument panel is equipped with heat pipes to reduce the temperature across the panel.

**4. Attitude-Control Subsystem**

The attitude-control subsystem performs two different functions; i.e., automatically acquiring earth-oriented attitude upon orbital injection, and maintaining sub-point pointing in order to ensure accurate positioning of the satellite and parallel scanning by the scanning radiometer. The subsystem uses a digitized automatic control technique and consists of three segments: the attitude-determination segment, the attitude-control segment and the executive-mechanism segment. It has two conic infrared scanning earth sensors for measuring the roll and pitch angles and three rate gyros which, together with the infrared sensors, form an orbital compass for estimating the yaw attitude. In addition, it has three mutually perpendicular zero-momentum reaction flywheels for maintaining three-axis earth orientation and for absorbing disturbance torques, and three jet nozzles which provide the required control torque for attitude acquisition and for de-saturating the flywheels during satellite operation. It also has a digital control computer and three compressed-nitrogen bottles and nitrogen supply lines. The pointing accuracy is less than 0.5° in the roll and pitch directions and less than 1° in the yaw direction. The attitude stability [i.e., drift rate] is 0.005°/sec in all three axes and the moment of momentum of the flywheels is plus over minus 1.2 newton.m.sec.

**5. Remote-Sensing and Environment-Monitoring Subsystem****(1) Infrared and Visible-Light Scanning Radiometer**

The radiometer has five channels, as shown in Table 1. The satellite has two radiometers, one of which is a back-up unit. The main functions of the radiometer are as follows:

- it can produce digitized picture signals with a resolution of 1.1 km for the satellite subpoint at a 900-km altitude.
- any two of the 1st, 2d and 5th channels can be selected via ground control to produce linearly homogenized analog pictures with a resolution of 4.0 km.
- each channel has been calibrated in the laboratory in either the visible-light band or the infrared band to determine the radiation intensity of the measured object.

The radiometer consists of three segments: the optical scanning system, the electronics segment and the radiation cooling unit. The electronics segment includes a pre-amplifier, a signal processor and a frequency indicator. The performance data of the radiometer are presented in Table 2.

**Table 2. Performance Data of the Visible-Light and Infrared Scanning Radiometer**

Scanning speed	360 rpm
Output signal bandwidth	15.7kHz
Remote-sensing dynamic range	
Visible light	50-11,000 footlamberts
Infrared	200-320K
Infrared thermometric accuracy (S/N)	270K plus or minus 1K
Infrared NEAT	0.25K (corresponding to a 270K black-body object)
Visible-light sensitivity	greater than or equal to 2 (when reflectivity changes by 5 percent)
Field of view	1.2 milliradians
Cooling mechanism	Two-stage radiation cooling unit, controlled to stabilize at 105°K

**(2) Cosmic Ray Monitor**

The satellite is equipped with a monitor unit for detecting cosmic rays, as well as protons,  $\alpha$ -particles, and carbon, nitrogen, oxygen and iron particles in the inner radiation belt. It can measure the total number of charged particles along the orbit and transmit the data to the ground via either the real-time or time-delayed telemetry channels. The specific tasks include: monitoring the level of solar cosmic rays and charged particles in the inner radiation belt, the level of low-energy anomalies in the galactic cosmic rays, and measuring the total number of charged particles and recording the space environment around the polar region and within the radiation belt.

**6. Picture Transmission Subsystem**

The picture transmission subsystem consists of three segments: the real-time automatic picture transmission (APT) segment, the high-resolution picture transmission (HRPT) segment, and the record/playback or delayed picture transmission (DPT) segment. The APT and HRPT segments each have two transmitters with different carrier frequencies to provide frequency redundancy and improved reliability. Each of the two HRPT transmitters has its own antenna. The operation of the two APT transmitters can be selected using a radio-frequency switch, and they share a common antenna with the tracking beacon generator. The DPT segment contains a VHF transmitter and two magnetic tape

recorders, one of which is a back-up. The recorders are used to record the 4-km-resolution analog picture signals of the radiometer, the signal for correcting recorder jitter, and the time-delayed telemetry signal. The operation of the recorders is controlled by the on-board computer based on instructions sent from the ground. Prior to entering the coverage zone of the main receiving stations, the DPT transmitters are pre-heated, then the magnetic recorders are activated in a fast-playback mode; when the satellite leaves the coverage zone, both the DPT transmitter and the magnetic recorders are turned off. These operations are performed automatically under program control. The performance data of the APT and HRPT segments are presented in Table 3.

Table 3. Performance Data for HRPT and APT Systems

	HRPT	APT
Scan rate (lines/min.)	360	120
Resolution of received imagery (infrared and visible light, orbital height of 900 km)	1.1 km, satellite sub-point	4.0 km, homogenized
Carrier frequency	1695.5MHz, 1704.5MHz	137.035MHz, 137.795MHz
Transmitter output power	8.0 watts	8.5 watts
Modulation	PCM-PSK, split-phase code waveform	AM-FM
Modulation index	plus or minus 67.5° plus or minus 7.5°	Carrier frequency deviation plus or minus 17kHz, sub-carrier 2.4kHz plus or minus 0.3kHz
Image baseband signal		AM 82-92 percent (peak)
Code rate	0.6654Mbps	0-1.6kHz
Transmitter freq. stability	plus or minus $\times 10^{-5}$ rms value	plus or minus $\times 10^{-5}$ rms value
Antenna		
Gain (62° from bore-sight)	-0.20dB (min.)	-2.94dB (min.)
Polarization	right circular	right circular
Ellipticity (max.)	less than or equal to 4.0 dB	less than or equal to 3.0dB
EIRP (62° from boresight)	37.8dBm (min.)	35.00dBm (min.)
	40.8dBm (max.)	40.2dBm (max.)

## 7. Telemetry and Control Subsystem

The telemetry and control subsystem consists of three segments: the tracking and tachometer segment, the telemetry segment and the remote-control segment. The telemetry uses the PCM [pulse code modulation] system

with both real-time and time-delayed (i.e., using magnetic recorders) capabilities. The telemetry signals contain on-board engineering parameters and measured cosmic-ray data.

## III. Ground Reception and Test Results

A considerable amount of operational tests, measurements, and a number of experiments were conducted shortly after satellite orbital injection; these tests produced a large number of HRPT, APT and DPT pictures and a large amount of data. The received pictures were processed and analyzed by the ground data processing center to yield valuable meteorological and oceanic information. By using ground markers, it was verified that the subpoint resolution of HRPT pictures was indeed 1.1 km, and the resolution of the DPT and APT pictures was 4.0 km. Other data on the pictures also met design requirements. Although the DPT signals and the transmission system are both analog, their picture quality approaches that of HRPT. Examples of the received pictures are shown in Fig. 5 -Fig. 14 [photographs not reproduced; captions are given below]. The transmitted signals of HRPT and APT have sufficient strength to be received by relatively inexpensive receivers. A large amount of valuable cosmic-ray information was obtained.

Fig. 5 APT, Visible-Light Channel 1, 11 Sept 1988 15:58 (Beijing time)

Fig. 6 APT, Visible-Light Channel 2, 11 Sept 1988 15:58 (Beijing time)

Fig. 7 HRPT, Oscilloscope Photograph, 13 Sept 1988 06:12 (GMT). Typhoon No. 14 in the Central Pacific region; the strength of the typhoon and its center are clearly indicated.

Fig. 8 HRPT, Oscilloscope Photograph, 7 Sept 1988 08:00 (GMT). Visible-light cloud map around Lake Baikal in the Soviet Union; the fiber-like cirrus clouds are clearly visible.

Fig. 9 HRPT, Oscilloscope Photograph, 7 Sept 1988. The first spliced visible-light picture; the cyclone system at the border region of Sichuan, Hubei, and Shaanxi is visible.

Fig. 10 HRPT, Oscilloscope Photograph, 19 Sept 1988 18:54-20:50 (GMT). The first spliced infrared picture; the structure of the tropical cyclone system southeast of Taiwan is clearly visible.

Fig. 11 DPT, Visible-Light Channel 1, 14 Oct 1988 06:47-06:56 (GMT).

Fig. 12 DPT, Oscilloscope Photograph. The cloud system above the Bay of Bengal and Sri Lanka.

Fig. 13 DPT, Oscilloscope Photograph, Visible-Light Channel 2, 20 Sept 1988, 11:27 (GMT). Cloud map over Southwest Asia; the Persian Gulf, the Gulf of Oman and the Arabian Peninsula are clearly visible.

Fig. 14 DPT and HRPT Spliced Picture, Oscilloscope Photograph.

The authors would like to express their sincere thanks to Zhang Luqian of the Technology Committee of the Ministry of Aeronautical and Aerospace Industry for his continuing interest and guidance in this work.

### Rise, Development of Space Technology in Shanghai

90CF0030B *Shanghai ZIRAN ZAZHI [NATURE JOURNAL]* in Chinese Vol 12 No 8, Aug 89 pp 580-583

[Article by Yin Rongchang [1438 2837 2490], Shanghai Space Bureau, Ministry of Aeronautics and Astronautics Industry]

[Text] At 5:30 Beijing daylight savings time on 7 September 1988, the Taiyuan Satellite Launch Center successfully launched China's first meteorological satellite, the "Fengyun 1" into a sun-synchronous orbit. The "Long March 4" launch vehicle was designed, developed and built by the Shanghai Aerospace Bureau, and the "Fengyun 1" satellite was developed by the Shanghai Satellite Engineering Research Institute. This was another important achievement in the history of China's aerospace development; it also marked a new stage of Shanghai's space technology development.

#### I. The Rise of Shanghai's Aerospace Industry

Shanghai, which is one of China's important industrial bases, has a comprehensive industrial system and solid material foundation, as well as rich technical resources. In the 1950's, research organizations in Shanghai had already developed sounding rockets for high-altitude exploration; they were among the pioneers of space-science investigation in this country. However, on its way to becoming a key industrial base in space technology, Shanghai experienced several difficult stages.

(1) Early Stage of Building a High-Technology Base. China's space technology and space industry have usually built on the foundation of its missile industry; Shanghai was no exception. In the early 1960's, in response to directives issued by the Party Central Committee and the State Council, efforts were initiated to establish a new technology base in Shanghai to be led by the Shanghai Space Bureau; it was to develop surface-to-air missiles. At that time, China was in a very difficult period economically, and Shanghai had no missile factories or technical personnel trained for missile development; everything had to be built up from ground zero. Under those adverse conditions, the City Council and City Government began to build production facilities by converting and expanding commercial factories, and to train a team of engineers and technicians in the area of missile design, manufacturing procedures, and management skills. They also took advantage of Shanghai's technological and industrial strength to form a network of nearly 100 different organizations. In addition, they cooperated with 200 other organizations around the

country, and within a period of only 4 years, China's first surface-to-air missile was developed. On the basis of this initial success, they continued to grow and develop innovative weapon systems for our military services. During this stage, valuable contributions were made to China's national defense.

(2) Formation of the Aerospace Industry. In the late 1960's, the Party Central Committee and the State Council directed Shanghai to establish its aerospace industry and to accelerate the development of its new technology base. As a result, a new effort was initiated where existing factories were renovated and expanded to form new production facilities. With the cooperation of more than 300 factories, research organizations and academic institutions, the new project proceeded rapidly. In 1975, an 1107-kg satellite was developed and injected into geosynchronous orbit by a launch vehicle which was also developed and built in Shanghai. These accomplishments marked a new stage of Shanghai's technology development, i.e., the formation of a new industry—the aerospace industry. Shanghai's aerospace industry soon became a key segment of China's aerospace industry.

(3) Development and Growth of Shanghai's Aerospace Industry. In 1977, the Shanghai aerospace community participated in the development of a large launch vehicle (the "Long March 3") for launching communication satellites. In 1978, an independent effort was initiated to develop the "Long March 4" launch vehicle for launching meteorological satellites. Since that time, Shanghai's aerospace industry has entered a stage of steady growth and innovative development. Since its first successful launch of a communications satellite in 1984, the "Long March 3" completed three additional launch missions; in 1988, a successful launch of the "Fengyun 1" meteorological satellite was accomplished by the "Long March 4" launch vehicle. These accomplishments have clearly demonstrated the technical capabilities and high standards of Shanghai's aerospace industrial base.

#### II. Accomplishments of Shanghai's Aerospace Industries

Aerospace engineering involves highly integrated and highly complex systems engineering issues. Launching of a new satellite requires the development of a launch vehicle which meet the payload requirements; it also requires building a launch facility which provides the functions of testing and launching the launch vehicle and the payload, tracking, safety control, orbit determination, telemetry and control, and processing data transmitted by the satellite. Thus, an aerospace engineering project generally involves five major subsystems: satellite, launch vehicle, launch operation, telemetry and control, and ground applications. The Shanghai aerospace industry plays a variety of research and development roles in each of the five subsystems; in particular, it plays a key role in the satellite and launch-vehicle subsystems. So far, China has launched 25 satellites, 12

of which were developed and launched by the Shanghai aerospace community. The accomplishments of Shanghai's aerospace industries over the past 20 years can be exemplified by the following four successful launches:

(1) Successful launch of a large experimental satellite by the "Fengbao 1" [FB-1] launch vehicle. On 26 July 1975, the "Fengbao 1" launch vehicle sent a 1,107-kg satellite into its designated orbit; this was the first major contribution made by Shanghai's aerospace community for China's aerospace development. The success of this project was attributed to the creative talents and hard labor of large number of researchers and engineers; during this project, significant achievements were made in new technologies, new procedures and new materials, which has greatly enriched China's rocket technologies. Shanghai's participation in launch-vehicle development was 5 years behind the launch of China's first satellite, the "Dongfang Hong 1" [DFH-1], and 18 years behind the world's first satellite launch (1957) by the Soviet Union. But the first Soviet satellite was only 83.6 kg, whereas the satellite developed by the Shanghai aerospace industry was over 1,000 kg; clearly, today's technology is greatly improved over that used by the first Soviet satellite, particularly in the areas of launch capability and guidance accuracy. Therefore, while Shanghai had a late start in satellite development, it has made considerable progress and technical improvements in the overall design, the rocket structure, and in the propulsion and control systems, so that it is approaching the state-of-the-art in aerospace technology.

(2) Successful launch of a launch vehicle carrying multiple satellites: the "Three-in-One" experiment. On 20 September 1981, China's aerospace industry reached another milestone when the "Fengbao 1" launch vehicle carried three satellites for space-physics exploration into closely-spaced orbits. This made China the fourth entity in the world to have multiple-satellite launch capability, after the Soviet Union, the United States and the European Space Agency. To launch three satellites simultaneously imposes new requirements on the launch vehicle, e.g., addressing the issue of structural dynamics caused by multiple satellites, developing multiple-satellite deployment techniques, and improving the guidance system for accurate orbital injection. It was major breakthroughs in these technical problems that placed Shanghai among the top aerospace communities in the world.

(3) Successful launch of a geosynchronous communications satellite by the "Long March 3" launch vehicle. The "Long March 3" is a multi-functional, three-stage liquid-propellant rocket; the first two stages are based on the prototype design of the "Fengbao 1" launch vehicle, and the third stage uses a liquid hydrogen-liquid oxygen low-temperature, high-energy propellant developed in Beijing. Most of the instruments and ground equipment used in the control, telemetry and ballistic-measurement systems were developed by the Shanghai aerospace community. The lift-off thrust of the rocket is 2,800 kN. The "Long March 3" was successfully launched on 8 April

1984. Its main technical accomplishments include: achieving the capability to carry a 1,430-kg communications satellite into a transfer orbit with an apogee of 36,000 km; developing a high-energy, low-temperature hydrogen-oxygen engine; and developing the technique of secondary ignition of the hydrogen-oxygen engine under weightless conditions. During the development of the "Long March 3," a major breakthrough was made in rocket structural dynamics and hydraulic-system dynamics by solving the longitudinal coupled-vibration problem. This achievement not only provided valuable experience for China's launch-vehicle development, but also stimulated the development of other related sciences in this country.

(4) Successful launch of the sun-synchronous meteorological satellite, the "Fengyun 1," by the "Long March 4" launch vehicle. The "Long March 4" was independently designed, developed and built by the Shanghai aerospace community. It is a highly reliable, highly flexible and relatively low-cost multi-functional launch vehicle which can be sent up from any launch site in this country. The "Long March 4" is a three-stage liquid-propellant rocket which uses normal-temperature propellant; its lift-off thrust of 3,000 kN is the highest of the "Long March" series of rockets; it has the capability to carry a 1,400kg-4,000kg payload into sun-synchronous orbits at different altitudes. On 7 September 1988, China's first meteorological satellite, the "Fengyun 1," was successfully launched into a 901-km sun-synchronous orbit. This achievement was made possible by the dedication of the scientists and engineers of Shanghai's aerospace community over the past 10 years and by their innovative solutions to many difficult technical problems. Specifically, many new technologies such as the digital attitude control system, the three-stage helium supercharged supply system, the three-stage thin-wall common-base fuel tank, the three-stage bi-directional wobble servo-mechanism, the three-stage engine, the engine compartment and the dry-hydrazine surface-tension fuel tank were all successfully flight-tested.

Based on the above discussion, it is clear that Shanghai's aerospace industry has attracted world attention for its technical accomplishments; furthermore, the industry is also playing an important role in China's economic development and scientific research.

### III. Special Characteristics of Shanghai's Aerospace Industry

Shanghai's aerospace industry was built on the foundation of the surface-to-air missile industry. Over the past 20 years, the industry has struggled through the early difficult period, then it enjoyed substantial growth and development through the period of reforms. As a result of many years of experience in research, production and testing, certain unique characteristics have evolved within Shanghai's aerospace community.

(1) Formation of a new structure. The new structure formed by Shanghai's aerospace industry consists of

three main segments: launch-vehicle segment, missile weapon segment, and commercial product segment. The new structure is designed to promote cooperation between military and commercial activities. Under this structure, improvements in missile technology and technical innovations and breakthroughs in aerospace technology are reflected in commercial products in the form of annual growth in economic benefits.

In addition to its continuing efforts to promote scientific research, to monitor high-technology development around the world, and to explore new horizons in aerospace technology, the Shanghai aerospace industry is also devoting considerable attention to the commercial application of its mature research achievements and to the development of commercial products for both domestic and foreign markets. It is their goal to provide their service for domestic economic development and for the expansion of international markets. Over the years, the Shanghai aerospace industry, represented by the Shanghai Space Bureau, has developed commercial products in the following seven categories: broadcast television, communications equipment, household appliances, instruments and gauges, medical equipment, electronic computers, and electromechanical equipment. More than 100 products, which include facsimile machines, television sets, microphones, recorders, washing machines, refrigerators, ceiling fans, air conditions, microwave ovens, electro-magnetic stoves, nickel-cadmium batteries, conducting-plastic potentiometers, and forging machines, have enjoyed excellent reputation on the commercial market. In addition, the satellite TV receiving system, the dual-center color TV equipment, the educational robot, the bloodflow conversion meter, and the electronic alarm system developed by the Shanghai aerospace industry are considered to meet state-of-the-art technical standards. At the same time, efforts have been made to incorporate imported technologies in domestic products, e.g., the air-conditioning system, the ignition system, the electrical equipment integrated assembly, and the automated spray-paint facility of the Santana automobile.

In short, the new structure has created a new environment where advances in aerospace and missile technologies will stimulate development in general science and technology, thereby expanding services from national defense to economic development.

(2) A strong technical team. High-technology research and development requires a large team of highly qualified scientists and engineers; a large engineering project requires long-term commitments from dedicated and creative technical personnel. For example, during the development of the "Long March 4" launch vehicle, the research team struggled for 10 years before achieving final success; the value of their creative labor is reflected in the instant of launch of the rocket, and in the continuing benefits derived from the orbiting satellite. Ten years is a very short time in human history, but it

was a long and curvy road for the engineers and technicians who had to overcome one difficulty after another, and make repeated personal sacrifices for the success of the project.

The many years of research and production activities have created an aerospace team which is technically superior, mentally strong and persistent, and capable of absorbing and digesting advanced technologies from abroad. This is a team of experts in system design, new materials, new manufacturing techniques, automatic-control technology, computer technology, radio remote-control technology, infrared technology, inertial-equipment technology, hydraulic-servo technology, energy-resource-development technology, and special processing techniques; they have successfully applied their expertise in the development of launch vehicles.

Over the years, this technical team's members have devoted their lives to China's aerospace industry; they were the primary force which was responsible for the growth of the industry and for raising China's aerospace products to world standards. During the progress of this team, organizations around the country provided strong support; in particular, academic institutions were a continuous source of top engineering talents with a high degree of political awareness. These were the main factors behind a successful technical team.

(3) Establishment of a new management system. The development of a large launch vehicle is a complicated systems engineering project which requires careful organization. Over the years, we have formed a "Four-Assurance Organization" which includes the executive command system in charge of planning and personnel assignment; the technical command chain centered around the chief designer system; the overall quality-control system for research and development, production, and testing; and the ideological and political operating system. The organization centers around a responsibility system with a tightly organized and strictly controlled network. Experience has shown that this management approach is quite effective. The executive command system's mission is to strengthen the management of research and production, to clarify management goals, to assign individual responsibilities, and to improve operating efficiency. The chief designer system is a modern organization and management system for large-scale research and development projects. In the development of the "Long March 4," the effectiveness of the chief designer system was demonstrated by the timely and efficient coordination of all the subsystems during each stage of the development; the feasibility and reliability of the integrated design approach were also demonstrated, where systems engineering principles were implemented in practice, and the talents of scientists and engineers were utilized to their full potential.

A fundamental policy that is essential in aerospace engineering is "Quality First." The important guidelines for research and development projects are: "Maintain a serious attitude, pay attention to details, and emphasize

safety and reliability." A rocket is an integrated system which consists of many subsystems and tens of thousands of units, components and parts; the malfunction of a single element may result in the failure of the entire system. To improve quality control, not only is it necessary to enhance the political awareness and the sense of responsibility of the personnel, but also to establish a robust management system and to maintain strict control over technical performance of the system.

Another fine tradition of the aerospace industry is the thorough ideological and political training of the personnel. With the strong support from the Communist Party and the Government, political propaganda and education programs are instituted at different stages of the engineering project.

These efforts to enhance political awareness provide the assurance for completion of the aerospace industry's mission.

(4) Establishment of a cooperative network system. Because of the high degree of complexity and the technological sophistication of an aerospace engineering project, generally many different disciplines are involved, and the success of a project requires cooperation and coordination among all the disciplines. The several hundred organizations which participated in building the various subsystems must be carefully organized and closely coordinated to form a unified force.

Faced with the challenge of the new technology revolution, an increasing number of countries besides the United States and the Soviet Union are interested in developing aerospace technology. In order to maintain China's position as one of the advanced nations of the world in aerospace technology, the Shanghai aerospace industry must acknowledge the important role it is playing, and continue to develop its technical capability and to make new contributions to China's economic construction.

**Cloning of Gene Relative to Invasive Ability of *Shigella Flexneri* 5**

40091001a *Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese* Vol 16 No 4, Aug 89 pp 305-311

[English abstract of article by Su Guofu [5685 0948 1381], Xu Yongqiang [1776 3057 1730] et al., of the Institute of Biotechnology, Academy of Military Medical Sciences, Beijing]

[Text] A genomic library of the *S. flexneri* 5 large plasmid (140 Md) was constructed using the cosmid pJB8 as the vector. There were more than 4,000 transformants in the library. A total of 66 clones were selected from the library by hybridization with the 17 kb gene probe relative to invasive ability. A few clones were analyzed. The results indicated that all clones tested contained recombinant plasmids and could hybridize with the 17 kb gene probe. When these recombinant plasmids were digested with *Eco*R1, the 17 kb fragments which hybridized with the 17 kb gene probe always existed in the recombinant plasmids. This demonstrates that all the recombinant plasmids contained the DNA fragments relative to invasive ability, and offers the possibility of constructing an oral living vaccine against *S. flexneri*.

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**Constitutive Expression of Human Fibroblast Interferon Gene Controlled by SV40 Early Promoter in CHO Cells**

40091001b *Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese* Vol 16 No 4, Aug 89 pp 312-317

[English abstract of article by Wang Xiaoming [3769 2556 7686], Yu Man [0060 2581] et al., of the Institute of Microbiology and Epidemiology, Academy of Military Medical Science, Beijing; Wu Shuhua [0702 3219 5478], et al., of the Institute of Virology, Academy of Chinese Prevention Medical Science, Beijing]

[Text] The *Hind*II fragment encoding human fibroblast interferon (IFN $\beta$ ) gene coding sequence was fused at 60 bp downstream from the RNA start site of the SV40 early gene, becoming the constitutive expression plasmid pSVE $\beta$ . This recombinant plasmid was transfected into dihydrofolate reductase (dhfr)-deficient Chinese hamster ovary (CHO) cells together with a selectable dhfr gene. Approximately half of the transformants continuously secreted IFN $\beta$  into the supernatant without inducement. One of the subclone transformants constitutively produced up to 852U IFN $\beta$ /2 x 10<sup>6</sup> cells/ml in 48 hours in a common medium.

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**LacZ Gene As Selective Marker: Construction of Hepatitis B-Vaccinia Recombinant Virus in Primary Chicken Embryo Cells**

40091001c Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 21 No 4, Jul 89 pp 277-283

[English abstract of article by Zhong Wuwei [6988 2976 1218], Wu Xue [0702 7185] et al., of Shanghai Institute of Biochemistry, Chinese Academy of Sciences]

[Text] Using primary chicken embryo cells as the host cells, the LacZ gene was inserted into the vaccine strain of the vaccinia virus Tian-Tan and its attenuated strain Guang-9. The derived recombinant viruses can express  $\beta$ -galactosidase. When stained with X-Gal, they form blue plaques. By utilizing the recombinant virus carrying the LacZ gene as a transitive strain, a second recombination was performed with the plasmid containing the hepatitis B surface antigen (HBsAg) gene. The hepatitis B-vaccinia recombinant virus was thus constructed. This recombinant virus, which expresses HBsAg efficiently in the primary cell culture, is appropriate for development as a vaccine for clinical use.

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**Isolation of Polyhedrin Promoter of Nuclear Polyhedrosis Virus, *Autographa californica* (AcNPV) by Site-Directed Mutagenesis, Construction of Universal Expression Vector**

40091001d Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 21 No 4, Jul 89 pp 344-353

[English abstract of article by Li Yiping [2621 0076 1627], Wu Xiangfu [0702 4382 3940] et al., of Shanghai Institute of Biochemistry, Chinese Academy of Sciences]

[Text] The authors have constructed the universal vector pUAc-5 for gene expression in the *Autographa californica* nuclear polyhedrosis virus (AcNPV). The polyhedrin gene in the vector provided not only the homologous sequences for *in vivo* recombination with the nuclear polyhedrosis virus genome, but also the selective marker for *in vivo* recombinations. The inserted foreign gene can be expressed efficiently under the control of the promoter of the polyhedrin gene. In pUAc-5, there is a 5' fragment of the polyhedrin gene promoter and a complete leading sequence before ATG, as well as a 3' fragment with the complete termination signal of this gene. In addition, a polylinker has been inserted, ready for use, without requiring a specific reading frame. The promoter of the polyhedrin gene was separated from the polyhedrin gene using oligonucleotide-directed mutagenesis, and the BamHI site was introduced in place of one nucleotide upstream of ATG (-1). The uracil-containing

DNA template method was used, and the efficiency of mutagenesis was approximately 89 percent.

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#### Mumps Virus Polypeptides, Their Synthesis in Infected Chick Embryo Cells

40091001e *Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA]* in Chinese Vol 29 No 4, Aug 89 pp 244-251

[English abstract of article by Li Yanchun [2621 7159 2504] and Wu Bohua [0702 2672 2901] of the Department of Virology and Molecular Biology, Wuhan University]

[Text] Strain ME of mumps was grown in a chick amniotic cavity and purified by differential centrifugation combined with sucrose gradient centrifugation. The structural polypeptides of the purified virion were analyzed by SDS polyarylamide gel electrophoresis. Eleven polypeptides, with molecular weights between 35K and 72K dalton, were found. In addition, polymers of HN protein and F1, the large subunit of F protein, were detected. Hela, Vero and CE cells were infected with the ME strain of the mumps virus. The CE cell appears to be the most sensitive host cell. The CE cell was infected with the mumps virus and labeled with [ $^{35}$ S]-Met, SDS-PAGE, and was examined by autoradiography. It was found that at least eight polypeptides were synthesized in the host cells and that their molecular weights were between 26.5K and 94K dalton. The duration of the polypeptide synthesis in the cells was studied. The Pulse-Chase experiments demonstrated a post-translational procession of Fo—F.

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**Purification, Some Properties of Bacteriocin Produced by *Pseudomonas Solanacearum***  
40091001f Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 29 No 4, Aug 89 pp 284-292

[English abstract of article by Xie Daoxin [6200 6670 2500] and Fan Yunliu [5400 0061 0362] of the Molecular Biology Laboratory, Biotechnology Research Center, Chinese Academy of Agricultural Sciences, Beijing; He Liyuan [0149 4409 6678] of the Plant Protection Institute, Chinese Academy of Agricultural Sciences, Beijing]

[Text] The bacteriocin from strain M2 of *Pseudomonas solanacearum* was purified by ammonium sulphate precipitation and anion exchange chromatography. This bacteriocin was designated as solanacearicin M2, appearing as one band on polyacrylamide gels. The bacteriocin showed antagonistic activity when it was recovered from the band through electrophoresis. Solanacearicin M2 was sensitive to proteinase, pronase E and trypsin, but insensitive to RNase and DNase. As determined by SDS-PAGE, solanacearicin M2 consisted of two subunits with molecular weights of about 68,000 and 70,000. The bacteriocin present in a pH 7.3, 0.05 mol/L  $\text{KH}_2\text{PO}_4\text{K}_2\text{HPO}_4$  buffer was stable for 15 days at room temperature and for 90 days at 4°C. The solanacearicin M2 was inactivated after treatment at 65°C for 10 minutes.

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#### Antigen Signature Analysis of Dengue-2 Viral Strains in Hainan

40091001g Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 29 No 4, Aug 89 pp 299-302

[English abstract of article by Yang Peiying [2799 0160 5391], Si Bingxin [0674 3521 6892] et al., of the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing]

[Text] In this paper, the authors attempt to define the extent of antigenic variation among the dengue-2 viruses isolated from Hainan Province over a 3-year period (1985-1987). The dengue-2 viruses were compared to the prototype New Guinea B strain and were subjected to antigen signature analysis. Eight strains of dengue-2 virus were analyzed by three monoclonal antibodies (the flavivirus group, subcomplex dengue-2 type-specific reactive epitopes) over a range of antigen concentration.

Five of the eight dengue-2 viral strains proved to be antigenically homogeneous, while the remaining three strains proved to be heterogeneous.

Signature analysis provides a rapid and simple means of differentiating strains derived from different sources, and thus permits the changes or introduction of new dengue virus populations in certain geographic regions to be monitored.

This project was supported by the National Natural Science Foundation of China.

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#### Establishment, Primary Application of Non-OI *Vibrio Cholerae* Serotyping System (VBO)

40091001h Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 29 No 4, Aug 89 pp 307-313

[English abstract of article by Chen Tianshou [7115 1131 1108], Tian Wanrong [3944 8001 4767], et al., of the National Institute for the Control of Pharmaceutical and Biological Products, Beijing; Mo Meyi [5459 5019 0308] of the Sanitary and Antiepidemic Station of Guangdong Province, Guangzhou; Chen Gongli [7115 2162 4539] of the Sanitary and Antiepidemic Station of Fujian Province, Fuzhou; Zhou Yongzhi [0719 3938 4160] of the Sanitary and Antiepidemic Station of Henan Province, Zhengzhou]

[Text] A serotyping system for *Vibrio cholerae* non-OI is reported in this paper. With this typing system, 549 strains isolated from Guangdong Province, Fujian Province and Henan Province were typed. A total of 55 serotypes were found in these strains. Among them, the dominant types were VBO 2, 7 and 9.

The distribution of the serotypes was related to the different regions. In the authors' experiment, 19 serotypes were new types, differing from the Sakazaki or Smith strains. This VBO serotyping system could be used to type 83.79 percent of the tested strains.

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**Isolation, Purification, Physico-Chemical Properties of Antibiotic 861-A Used for Wheat Scab Control**

40091001h Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 29 No 4, Aug 89 pp 317-319

[English abstract of article by Jin Tongming [6855 0681 6900], Song Jiaxiang [1345 1367 4382], et al., of the

Institute of Atomic Energy, Chinese Academy of Agricultural Sciences, Beijing; Bian Zeliang [0593 0463 2856], et al., of the Institute of Chemistry, Chinese Academy of Sciences, Beijing]

[Text] The antibiotic 861 complex, isolated from *Streptomyces roseoalutaceus* var. *pallidus* by ion exchange chromatography, exhibits a broad antibacterial spectrum and a unique controlling efficiency to wheat scab, which is the major wheat disease in China. The complex was further purified by carbon column, acetone precipitation and CM-Sephadex G-25 ion exchange chromatography or high-performance liquid chromatography, and 861-A, the major effective component, was then obtained.

The antibiotic 861-A is basic, hydroscopic white powder. It is very soluble in water, but not soluble in normal organic solvents. A series of physico-chemical properties indicate that 861-A is a N-glycoside compound and is identical to streptothricin F.

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**Computer Viruses Are Here Too**

40100007A Beijing CHINA DAILY in English  
4 Nov 89 p 3

[Article by Qin Xiaoli and Qian Jiang]

[Text] A computer was doing its word processing, the cursor blinking brightly on the screen. Suddenly, a jumping white ball appeared. Then a second one, then a third..., slowly the screen was full of them. Operation stopped.

This was a demonstration of the "small ball" computer virus at the Computer Safety Meeting last week in Kunming in Yunnan Province.

China has 300,000 computers. A survey by the Ministry of Public Security in August found 10 percent of the computers they checked were affected by a virus.

Yang Zhihui, senior engineer and deputy chief of the Department of Computer Safety with the Ministry of Public Security, said computer viruses have spread in China and the government is attending to the problem.

Of the country's national networks, the statistics network is affected the most. The small ball virus has been found in 21 provincial, municipal, and autonomous regional bureaus.

"Luckily, from what we know now, small ball is not malignant. It slows computer operation and sometimes stops the machine but it doesn't spoil the memory," he explained.

Of individual users, Yang said, universities are the most afflicted.

"In Wuhan University, we checked every single machine and found them all affected," Yang said.

So far, three kinds of virus have been reported in China: the small ball, the marijuana, and the shell. All of them were traced to overseas sources.

"We have already worked out some vaccination and sterilization programmes for the virus," Yang said, adding that the task couldn't be handled single handedly by the Ministry of Public Security.

"There are too many types of machines imported from different countries or made by domestic factories, and there are too many different systems which require different sterilization," he said. "As one safety model for the whole country is not possible, users should be organized to co-ordinate in the work."

"Customs offices can check imports of viruses, but they can't cover all imports as no office can check every different kind of software," he said.

The Ministry of Public Security has been charged with computer safety since 1981 by the State Council and its local offices across the country all have people who specialize in computers.

The ministry recently issued a document asking units with computers to enhance safety training of computer operators, set up safety checks to inspect imported software, and report to the local public security offices any virus as soon as it is discovered.

The ministry also ruled that research on viruses and the use of sterilization programmes should first get approval from the ministry. No one is allowed to disseminate results of virus research.

**Cure for Virus in Computers**

40100007B Beijing CHINA DAILY in English  
17 Nov 89 p 3

[Text] (XINHUA)—Liu Yongshen, an engineer of the Shanghai Qiming Software Co Ltd, has developed a device which is able to automatically diagnose and clear away the ball-type computer virus, according to the Shanghai-based LIBERATION DAILY.

Over 30 types of computer viruses have been discovered in the world so far. Many of them have also been found in the microcomputer systems in China and often cause serious damage. Among all the computer viruses, the ball virus is the most common.

Liu solved the riddle of the ball-type virus and developed the new device, which can be used to examine any micro-computer system to see whether it harbours this type of virus and automatically clear it.

The Shanghai Qiming Software Co Ltd is a Sino-Japanese joint venture located in the Caohejing new technology development zone in Shanghai.

**CAS Launches Global Business in Computers**

40100007C Beijing CHINA DAILY in English  
20 Nov 89 p 3

[Text] An institute under the Chinese Academy of Science (CAS) has launched a global business, composed of a research centre, manufacturing base and an international sales network.

CAS' Institute of Computing Technology, which employs hundreds of outstanding Chinese computer engineers, established the Legend Computer Company Ltd in Hong Kong last April with an investment of 900,000 Hong Kong dollars (\$115,385).

The company recouped its investment in three months and had a turnover of 120 million Hong Kong dollars (\$15 million) in its first year of operation. In the first seven months of this year, the firm had a turnover of 170 million Hong Kong dollars (\$22 million).

In August of last year, the company bought a Hong Kong manufacturing enterprise, Quantum. Within six months, Quantum developed four new products for overseas markets.

Since attending international computer fairs in West Germany and the United States early this year, the company has received monthly orders of 4,000 computers.

Quantum also sells 3,500 CAS PC-ATs a month in Europe and North America.

In order to gain a firm hold in the world market, the Chinese Academy of Sciences last Tuesday announced the founding of the Beijing Legend Computer Group Co, which will also have a branch in Hong Kong.

Legend has a sales and service centre in Singapore and will establish another in the United States next year.

The firm is also planning an overseas stock offering before 1993 according to a CAS official.

Looking back on the road China has followed, a senior government computer official said that China has taken two strategic steps in developing its computer industry, which dates back to 1956.

According to Li Ye, director of the computer department of the Ministry of Machinery and Electronics Industry, during the first stage—the 1956-79 period—technical research and exploration were the focus of computer development, aimed at serving the departments of national defence. The Series 100 minicomputers and Series 200 medium-sized computers were among the major products that made their market premiere during the period.

In the second stage, 1980 to the present, economic reforms and the open-door policy have been the driving force, impelling the computer industry to grow at an annual rate of 30 percent. During this 10-year period, new generations of personal computers have captured more than 60 per cent of the domestic market. Minicomputers include the Model 2000 series products, which make up close to 40 per cent of the market.

The Zhonghua brand learners computer made its debut on the market in 1987 and over 80,000 have been turned out so far. The computer has been a hot commodity among teachers, school children and families with children.

Over one hundred models of industrial control computers, single-board computers and programmable controllers have been developed. Other Chinese-made products include peripheral equipment required by host computers, medium and low-grade monitors, dot matrix printers and disk drives.

With regard to computer software and its applications, China has so far succeeded in developing a number of software programmes, such as those for office automation, drafting, Chinese-English translation and graphics processing.

The Huaguang Chinese-character laser editing-typesetting computer system and document typesetting system in the various languages of China's minority nationalities are the most distinctive products of Chinese-character word processing systems.

Chinese-made work stations have been created for automation product design.

#### Shenzhen-Taiwan-Hong Kong Computer Joint Venture Formed

40080004d Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 40, 18 Oct 89 p 1

[Article by Chen Hao [7115 3185]: "Pioneer in High-Tech-Oriented Cooperation: Shenzhen Pioneer Electronics, Ltd., Formally Starts Business"]

[Summary] Shenzhen Pioneer [Xianqu] Electronics Ltd., a joint venture set up by the Saige [6357 2706] Computer Company of Shenzhen, by Hexing [0735 2502] Data Communications [zi xun 6327 6061] Ltd. of Taiwan, and by Binhai ["Coastal," 3453 3189] Enterprises of Hong Kong, formally opened for business on 4 September in Shenzhen. The three-party joint venture, capitalized at US\$1 million, will develop, manufacture, and market various computer floppy disk drives, peripherals, and associated items. Current output of 3000-5000 units per month will be stepped up to 100,000 units annually in phase two of the developmental plan, and in phase three another production line will be added to permit a gross annual output of 200,000 units. These products will be sold mainly overseas.

## New CNC Machine Tools, Machining Centers Unveiled at CIMT'89

90CF0041A Beijing JICHUANG [MACHINE TOOLS]  
in Chinese No 8, Aug 89 pp 14-16

[Article by Jiang Xuewen [1203 1331 2429], a correspondent of the journal: "Metal Cutting Machine Tools Unveiled at CIMT'89"]

[Text] key words: metal cutting machine tools, China exhibition hall.

In the first Chinese International Machine Tool (CIMT'89) Exhibit held at the Shanghai Exhibition Center on 9 May, the China exhibition hall had a net display area of 2333 m<sup>2</sup>. A total of 215 factories, corporations and groups participated in this event, and 145 machine tools and large-size instruments were in display, including 52 CNC (computer numerically controlled) machine tools (i.e., 36 percent of the machine tools on display), eight machining centers, four CNC grinders and one CNC boring machine. These products not only reflect the technical level of China's machine tools but also indicate the developmental trend of the machine-tool industry in China.

### I. New Machine-Tool Products

In last year's machine-tool industry exhibit, over 210 new machine tools were on display. At CIMT'89 the China exhibition hall showed a number of new products developed in the past year. For example, the Model TC500 (TH6150) machining center exhibited by the Nanjing Machine Tool Plant was developed by Werner Kolb Machine Tool Company of the FRG in 1984. It takes 18 seconds to exchange trays and is equipped with a chain of 60 (or 40) cutting tools. It takes 3 seconds for the robotic arm to replace a tool. The vertical structure of the machine tool employs a double wall frame design. It was designed based on the thermal symmetry principle to ensure high rigidity and accuracy. The overall structure is very rigid and does not require a solid base for installation. The machine tool is equipped with a dual position automatic position change (APC) worktable, internal and external cooling for high-rate tools, and a completely sealed enclosure. It is capable of high-speed cutting. This machine tool is especially suitable for small and medium batch production involving machining of precision case-type parts. The machine tool employs the Siemens 8VE control system and uses the Heidenhain grating scale to measure each element; the precision of location is 0.015 mm. Three (or two) of the four coordinates can move at the same time. It may be integrated into a flexible manufacturing system for unattended operation.

The Model H166/1 CNC crankshaft grinding machine developed by the Shanghai Machine Tool Plant is suitable for large batch production. Once a piece is set up, it automatically grinds off the end, corner and cylinder of the neck of every shaft. In addition to automatic grinding of the whole shaft, it is also capable of the fine-tuning

type of grinding. The control program and parameters of the machine tool are displayed on a CRT for reference. The grinding-wheel feed is powered by a Fanuc Model 20M dc servomotor which is controlled by a Fanuc 3T-C numerical control system. The minimum feed step is 0.5  $\mu$ m. The Fanuc Mate-P numerical control system controls the Fanuc Model 00M servomotor which drives the profile adjusting wheel. In addition, it also automatically compensates the feed of the grinding wheel. The job is automatically divided without stopping the machine, the grinding wheel is automatically matched with the part, the work station automatically shifts gear, the center of the hydraulic frame automatically tracks the grinding process, and the Marposs instrument automatically measures each piece of a part being machined. The specifications of the machine tool are 10  $\mu$ m for radius and taper, 0.8  $\mu$ m for surface roughness R<sub>a</sub>, 1.6  $\mu$ m for ripple factor, 22  $\mu$ m for equal diameter, 20° for phase-angle tolerance, 0.1  $\mu$ m for crankshaft gyroradius, and 0.1  $\mu$ m for shaft neck width tolerance.

The Cortini Shanghai 200-CNC numerically controlled instrument lathe displayed by the Shanghai Instrument Machine Tool Plant is jointly manufactured with the Cortini Corporation of Italy. This machine tool is suitable for machining complicated parts for small instruments and meters and for teaching and training. It is a high-precision, compactly structured, easy to operate machine tool. The rotary tool rack can simultaneously accommodate five tools. It serves a wide range of operations and produces parts of consistent dimensions. The machine tool uses the Cortini CNC 2437 Mod/6 numerical control system which is capable of controlling two stepper motors continuously at an increment of 0.01 mm. Usually, it controls three axes with two-dimensional movement. There is a CAD-CAM interface and the maximum programmable dimension is 999.99 mm. There is room to store 679 program modules for open loop control. The maximum feed rate is 0.5 m/min and there is a 9-inch CRT to display real time position. It may also be connected to a printer, plotter, or magnetic tape drive. This machine can be used to produce parts for the instrumentation, light-manufacturing, electronic, medical-device and aerospace industries on an individual or batch basis. The main shaft rotates at 38-3800  $\gamma$ /min and the feed along the z and x axes is 5-550 mm/min (stepless). The minimum feed along the z or x axis can be set at 0.01 mm. The same plant also had the newly developed Model YS3616 high-efficiency hobbing machine on display. The duty cycle of the machine is achieved by an ac motor and some mechanical means. It can be programmed to finish the cutting in either one or two cycles, or, multiple cutting steps can be done in one cycle. The rotating speed of the tool and the feed can be preset. After finishing each task, the tool is automatically displaced to a preset location. The main structure of the machine is made of a highly rigid cast alloy. The transmission system is short, capable of maintaining very high static and dynamic stability. The sliding guide is wide and flat and is coated with a polymer. It has good vibration resistance. This machine tool was designed

specifically for the mass production of component machine tools, power tools and gears, and is compatible in manufacturing a large variety of parts in small batches. The layout of the machine is horizontal and the main work shaft does not move; the cutting process is done by moving the tool. The accuracy of the machine meets the Level 6 standard (JB179-83) set by the Ministry of Machine-Building and Electronics Industry. In addition to machining various gears, it can also be used to machine turbines, multi-thread bolts, and spline shafts. The same plant also exhibited a small Model L300 numerically controlled instrument milling machine. This is another product jointly manufactured with the Cortini Corporation of Italy, and it uses the CNC 2437 minicomputer for control.

The Model IEF70/NDH automatic internal grinder exhibited by the Wuxi Machine Tool Plant is a high-efficiency production-type grinder developed upon technology imported from the Cincinnati Milacron Corporation. The machine employs a novel servo feed system which guarantees accuracy to 0.25  $\mu\text{m}$ . The system is equipped with a pulse code feedback system and the feed rate can be as high as 80,8000 [sic] steps/min. The grinding wheel is fed into the part in a swaying manner. Furthermore, the same static pressure cylindrical guide is also used to move the grinding wheel back and forth. This reduces the mass of the moving parts and drive joints to ensure the accuracy described above. The control system of the machine tool uses the APC500 programmer. Dimension control includes fixed-range measurement, in-process measurement and post-process feedback measurement. The maximum speed of the grinding wheel is 120,000  $\gamma/\text{min}$ . It is the most advanced internal grinder made in China.

The Model XHF7610 copying machining center exhibited by the Shanghai Fourth Machine Tool Plant was independently developed based on absorbing the technology associated with similar products made in other countries. The machine is equipped with a Fanuc 6ME(B) control system and a Fanuc 330D copying system. It has numerical control machining capability, copying machining capability and a combination of both capabilities. It is suitable for machining large molds and complicated and irregular surfaces. The machining worktable is 1000 x 1650 mm (the copy worktable is 1000 x 1250 mm), the feed speed is 1-4000 mm/min (copying speed is 10-2000 mm/min), the accuracy of position is plus over minus 0.02 mm, and the range of main-shaft rotation speed is 10-4050  $\gamma/\text{min}$ . The capacity of the tool chest and the range of main-shaft speed are higher than those for similar products made in other countries.

The Shanghai Fifth Machine Tool Plant showed the Model MQ9020 CNC optical profile grinder which is suitable for machining precision molds. It consists of a precision projector, grinding tip with multiple degrees of freedom, and a CNC worktable. The resolution of the

CNC system made by General Electric, is 1  $\mu\text{m}$ . It is an ideal piece of equipment for machining modern molds and forming machine tools.

The Model LS-350X slow-moving electrospark wire-electrode cutting machine is manufactured by the Shanghai Radio Specialty Machinery Plant; the technology was imported from and licensed by the JAPAX Corporation of Japan. This machine can meet high-precision and high-productivity requirements and has advantages such as higher economy, low power consumption, and low failure rate. It is used to machine high-precision metals, hard alloy molds and sample sheet parts. The accuracy is plus over minus 0.005 mm, parallelism is 0.005 mm, and the surface roughness  $R_a$  is 0.1  $\mu\text{m}$ .

The Model TK4145 CNC jig boring machine displayed by the Ningjiang Machine Tool Plant is a new product developed upon the TG(X)4145 machine manufactured by the plant. It is a high-precision vertical single-column numerically controlled jig boring machine useful in drilling, boring, medium-duty milling, line engraving, graduation and taking measurements. With the aid of a rotating table or universal table, it can machine a polar coordinate hole or any bevel angle in space. It is suitable for machining parts with very tight requirements on positioning of holes, such as cold die-cast boring tools, augers, boring molds, etc.

## II. A Variety of Electro-Machining Machine Tools

The Model DK7725W numerically controlled electrospark wire electrode cutting machine is manufactured by the state-run Chengdu Radio Specialty Equipment Plant. The wire space can be continuously adjusted to cut parts up to 150 mm in thickness. It is equipped with a Model WXK-340 automatic programmable controller. This controller is a complete Chinese-character man-machine-dialogue automatic programming system, and is on the cutting edge of technology in China. It is capable of time-division control. The unit provides the user with two display pages, i.e., a programming page and a processing page. The track of cutting and actual coordinates of the cutting point can be monitored during programming.

The Model D7132NC numerically controlled electrospark forming machine tool manufactured by the Shanghai Eighth Machine Tool Plant employs a parallel numerical control system with a number of microcomputers. It uses a man-machine-dialogue operating mode and meets advanced technical standards of the 1980's. This machine is suitable for machining through-hole molds, hole-shaping molds, and complicated parts and cutting tools made of high-strength, high-hardness materials.

The Model A3C-ATC precision CNC electrospark machine tool manufactured by the Hanchuan Machine Tool Plant was given the "Spring Swallow" Award. Its production is a joint effort with the Sodick Corporation of Japan. The machine has a high-efficiency no-loss

processing NOW circuit and a mirror-surface machining PIKA circuit. It has the capability to store electric gauges and can be operated unattended over a long period of time. It can automatically find the origin and fix its own position and has the capability to control four axes, i.e., X, Y, Z and C. With the addition of an automatic tool changer (ATC) device, it becomes an electrospark machining center. The positioning accuracy of the machine is set to be within plus or minus 0.005 mm, the ATC is accurate to within plus or minus 0.003 mm, and the reproducibility of position is set to be plus or minus 0.003 mm (100 mm). The plant also makes the Model HCKX high-speed precision numerically controlled wire electrode cutting machine, which can perform a variety of machining tasks. It is a good piece of equipment for mold making. The plant also makes the Model HCD300 precision electrospark forming machine, which has an attractive look, a novel structure, a wide range of functions, and is easy to operate. It is a new-generation product and is equipped with the Heidenhain-155 numerical control system from the FRG.

The main shaft of the Model D7125-1 electrospark forming machine displayed by the Yingkou Electrospark Machine Manufacturing Plant employs an electrohydraulic servo system. The main-shaft feed system has a digital display and is equipped with a Model YDD-50A low-loss multi-functional transistor pulsed power supply.

The Model BDXP high-speed line polisher exhibited by the Beijing Electric Machining Research Institute can be used in high-hardness, high-speed and highly smooth finish machining. The same plant also displayed a polisher for super hard materials using a combination of electrospark and ultrasound.

### III. A Large Selection of Popular Products in Sight

Based on the products displayed in the China Exhibit Hall, we have demonstrated that the scope of usage of CNC machine tools has expanded in China and we are entering an export stage. The ratio of CNC machining centers on display is significantly higher than before.

#### 1. Machining Centers

The Model MVC-20 vertical machining center exhibited by the Beijing First Machine Tool Plant has man-machine-dialogue capability and it displays in four languages, including Chinese, English, German and French. The lower end of the main shaft uses the standard Timken round roller bearing and the upper end uses the Timken-Hydra-rib round roller bearing. The amount of force applied to pre-tighten the main shaft varies with the rotation speed of the main shaft in order to adjust the compressed air to ensure its high accuracy. This machining center is well received by an end user in Canada.

The Model TH5632 machining center displayed by the Dahe Machine Tool Plant uses a Fanuc ac main-shaft motor and it can operate at low speed with high torque.

The main structure of the machine is highly rigid. It does not use any gear-drive mechanism and the noise and vibration levels are low; also, there is little thermal distortion. It is suitable for heavy-duty cutting, and has high-speed positioning capability, i.e., 15 m/min in the X and Y axes and 10 m/min in the Z axis. It also has a high-speed tool-change capability. This vertical machining center has been exported in batches.

The Model H2-062 turning center (which received a "Spring Swallow" award) displayed by the Shanghai Heavy-Duty Machine Tool Plant is equipped with a power tool mechanism and a main-shaft servo-drive graduated positioning mechanism. In addition to turning, it also can be used in milling flat surfaces, key slots, radial spiral slots and end cam slots. Furthermore, it can also be used to machine a radial through-hole or a screw hole.

#### 2. Numerically Controlled, Digital-Display Machine Tools

The Model M52100A precision guide-rail grinder manufactured by the Shanghai Heavy Duty Machine Tool Plant is used to grind guide rails and flat surfaces of various shapes. The main shaft of the grinding tip is imported from the FAG Corporation in the FRG. It has high accuracy and good rigidity. The main shaft of the peripheral grinding tip is equipped with a hydraulic automatic balancing system manufactured by the Hofmann Corporation of the FRG; this system comes with a large balance mass. The machine operates either manually or automatically, and the amount of displacement is shown on the CRT. This machine was given a first-class "Spring Swallow" award at the China Machine Tool Exhibit.

The Model CWK360 numerically controlled lathe manufactured by the Changsha Second Machine Tool Plant meets 1980s standards. It has an attractive look, is highly rigid, has a high rotation speed and low noise and is totally sealed for protection. The factory also developed its own automatic programming system CAPS, which is equipped with a dynamic display and has an initial CAM machining system.

From the metal-cutting machine tools on display in the China Exhibition Hall, we have learned the following: The machine-tool industry has made a great deal of progress in the past 40 years. In particular, under the guidance of the open reform policy, the technical level of machine tools has been significantly raised through cooperation with other countries. Based on the products on display, we can see that the machine-tool industry in China is maturing. Gradually, it will be able to provide better products to customers outside China.

### New NC Machine Tools Unveiled

#### Economical NC Lathe Considered 'World Class'

90CF0085 Beijing ZHONGGUO JIDIAN BAO in Chinese 26 Sep 89 p 1

[Article by Shu Li [5289 4539]]

[Text] In the First International Integrated Electromechanical Tools Exhibit, the Model CJK6132A1 economy numerical control (NC) lathe made by the Guangzhou Machine Tool Plant has attracted the attention of quite a few companies from Japan and England. Some experts consider it a "world class" machine tool because of its micro-computer control and integrated electromechanical design. It has high accuracy, is compact in size, can operate as fast as 12 m/min, and costs three-quarters less than any comparable imported machine tools.

This economy model NC machine tool has been sold to over 30 countries and regions, including the United States and Canada. It is the top export seller in the machine tool industry.

#### Specifications of New NC Lathes Given

90CF0085 Beijing ZHONGGUO JIDIAN BAO in Chinese 3 Oct 89 p 3

[Advertisement]

[Text] **Guangzhou Machine Tool Plant Introduces the Original Technologically Advanced Model CJK6132A and CJK6146 NC Lathes**

Advanced design is used in these machine tools. The location accuracy of the four-position automatic rotating tool rack is better than 0.003 mm and its cutting roughness is under 3.2-1.6. It is 2-6 times more effective than a conventional machine tool.

Its characteristics include:

- It has a modular structure and uses a standard programming format.
- It operates as fast as 12 m/min and runs steadily at low speed.

- It is capable of protecting the machine from over-pressure, under-pressure, overflow and excessive frequency.
- It can handle both metric and imperial units and can do straight taper threading.
- It has a power-cutoff protection procedure and a variety of self-diagnostic functions.
- It costs less.

The company also manufactures an ac and dc servomotor NC lathe—Model CK6140. It also makes a series of 320, 360, 400, 460, and 560 mm-diameter universal and gap-bed lathes. We have ranked number one in exports 10 years in a row.

Address: 40 Xingang West Road, Henan, Guangzhou

Telephone: 449361

Telex: 9969

Postal Zip Code: 510260

The Model CJK6132A economy NC machine tool received an outstanding electronic machinery product award given by the State Science Commission.

### New Flexible Machining Cell Developed

90CF0085 Beijing ZHONGGUO JIDIAN BAO in Chinese 3 Oct 89 p 3

[Article by Wang Yining [3769 0076 1337]]

[Text] China's first high-precision, high-efficiency small flexible machining cell was certified by the Ministry [of Machine-Building and Electronics Industry] at the Ningjiang Machine Tool Plant. The tool magazine of the Model TR6340 high flexibility machine tool has a capacity of 70 tools with 8 automatic exchange trays. There are two electronic probes for automatic measurement and tool-life management. The accuracy of position and graduation of the rotating table are on the order of microns and at the coordinate level. Because the machine is equipped with the Fanuc 11MC numerical control system, it is very suitable for machining small prismatic parts and complicated curved surfaces involving a variety of continuous paths. This machine tool meets standards of similar products made in other countries in the 1980's. It fills a void in flexible machining in China.

**Fundamental Transverse Mode Stabilized  
GaAlAs/GaAs terraced Substrate Lasers**

906A0001A Shanghai ZHONGGUO JIGUANG  
[CHINESE JOURNAL OF LASERS] in Chinese Vol 16  
No 9, 20 Sep 89 (manuscript received 5 Feb 88)  
pp 513-517

[Article by Sun Chengcheng [1327 2052 1004], He Shufang [0149 3219 5364], Zhang Peiliang [1728 1014 0081], and Guo Yili [6753 1150 3810] of the Department of Radio Electronics, Qinghua University]

**[Abstract]** It is required that semiconductor lasers operate with a stabilized fundamental transverse mode in applications such as fiber-optic communications, optical disk storage, laser printing, fiber-optic sensing and optical data processing. This project applies the flat-plate waveguide approximation method in analyzing the waveguide mechanism of terraced-substrate with one-step liquid phase epitaxy (LPE). The concept and working formulas of the additional supercooling are presented, thus obtaining a terraced-substrate laser in stabilized operation with a fundamental transverse mode. Because of the epitaxial growth rate difference of the terraced portion and the flat portion, the active layer thickness of the terraced portion is greater than that of the flat portion, thus leading to refractivity. This is equivalent to adding a trough channel-substrate flat waveguide into a ridge waveguide. Nine figures show the structure of a TS laser; a simplified mode of a TS waveguide; a waveguide model used in computations; the relationship between ridge thickness and equivalent refractivity; the relationship between the limiting factor, on the one hand, and the total of active-region thickness and ridge thickness on the other hand; the relationship between epitaxial-layer thickness and growth time; an epitaxial chip; the far-field light-intensity distribution; and the (power vs current and voltage vs current) electrical characteristics of the TS laser. Approximate thickness of the layers are as follows: first, or lower-confinement layer (N-Ga<sub>0.7</sub>Al<sub>0.3</sub>As): 2 microns in terraced part, 0.3 micron in planar part; second, or active layer (p-GaAs): 0.38 micron in terraced part, 0.3 micron in planar part; third, or upper-confinement layer (P-Ga<sub>0.7</sub>Al<sub>0.3</sub>As): 1.5 microns in terraced part, 0.8 micron in planar part; and fourth, or isolation layer (n-GaAs): 0.5 micron in planar part. Low-current-operation parameters are as follows: forward inflection-point voltage at a 1-mA current is 1.0-1.2 V, and reverse-breakdown voltage at a 0.1mA current is 4-6 V. Operating-state parameters are as follows: characteristic value of threshold current is 78mA, with a minimum value of 55mA; linear output power can reach 7.6 mW (single surface). External differential quantum efficiency is 20 percent (single surface). Spectral characteristics are: line width is about 30 nm, and laser peak wavelength is 830-850 nm. The authors are grateful to Ma Chaohua [7456 2600 5478] et al. of the Seventh Conductor Laboratory, Chinese Academy of Sciences, for their assistance in the development of TS lasers.

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**Optical Chaos in Zero-Order Amplitude  
Stabilization Ring of Bragg Acousto-Optical  
Modulated Laser Light**

906A0001B Shanghai ZHONGGUO JIGUANG  
[CHINESE JOURNAL OF LASERS] in Chinese Vol 16  
No 9, 20 Sep 89 (manuscript received 29 Jan 88)  
pp 518-522

[Article by Liao Shiqiang [1675 0013 1730] and Wang Yuzhu [3769 5148 4554] of the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

**[Abstract]** Research on the interaction mechanism between optical and acoustic fields in an acousto-optical crystal in recent years has led to the properties of zero- and first-order diffracted light produced by using Bragg acousto-optical modulation. Stabilized laser oscillation amplitudes in the outer-loop channel can be realized. This project reports an experimental arrangement of stabilized (ratio of split beam) laser zero-order diffracted light oscillation amplitude by utilizing Bragg acousto-optical modulation diffracted light with a stability higher than  $5 \times 10^{-5}$ . The research includes the generation mechanism of laser chaos with a nonlinear effect involving an acousto-optical crystal in a self-controlled steady amplitude ring of high-gain acousto-optical modulation; the chaotic phenomenon was observed in experiments. Seven figures show a reduction of the effective acoustic field vector when the angle subtended between the incident light and an acousto-optical crystal deviates from the Bragg angle, an operational block diagram of amplitude stabilization (split-beam ratio) of a Bragg acousto-optical modulated laser, a dynamic block diagram of an acousto-optical self-controlled system, the process of the system in transition from a stabilized to a chaotic state, experimentally plotted curves of relative intensities for zero- and first-order diffraction light, an experimental block diagram for the laser chaotic state within the acousto-optical modulation self-controlled laser amplitude ring (apparatus includes a He-Ne laser, Bragg AOM, and an avalanche photodiode), and the transition of stabilized amplitude zero-order diffraction light from the stabilized to the chaotic state. The authors are grateful for valuable discussions by Li Shiying [2621 0013 5391] of the Shanghai Institute of Optics and Fine Mechanics, and Dr F. Picotto of the Italian Academy of Measurement Science.

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**Spectral Characteristics of LiF:OH Monocrystals**

906A0001C Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 9, 20 Sep 89 (manuscript received 30 Dec 87) pp 535-537

[Article by Lin Yuanqi [2651 6678 7871], Yang Baocheng [2799 1405 2052] and Ding Jingxin [0002 2533 2450] of the Department of Physics, East China Normal University; Li Shenghua [2621 0524 5478] of Shanghai Jiaotong University; and Fan Fuchang [5400 4395 2490] of Shanghai Institute of Optical Instruments]

[Abstract] Successful research on infrared-tuned lasers has been based on alkaline halide crystals as the color-center material for substrates. Generally, color-center lasers operate at the temperature of liquid nitrogen; however, such lasers using artificial LiF crystals as a substrate can operate at room temperatures. This project reports on the mechanism of enhancing the heat and light stability of a color core by blending an OH radical into a LiF crystal. In addition, the authors observed amplified spontaneous radiation (which is radiation of a string of zero phonon lines) in peroxide ions ( $O_2^-$ ) generated during coloration treatment of monocrystalline LiF:OH. Three figures show the absorption spectrum of LiF monocrystal, the experimental arrangement (including an Nd:YAG laser, a KDP crystal frequency doubler, a DCM dye laser, and an ADP crystal frequency doubler), and the emission spectrum of  $O_2^-$ . The authors are grateful to associate professor Ma Longsheng [7456 7893 3932] for beneficial discussion, and to Ding Liang'en [0002 5328 1869] and Yao Fanghai [1202 5364 3189] for assistance.

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**Triple Chopper, Detection of Doppler-Free Laser Opto-Acoustical Signals**

906A0001D Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 9, 20 Sep 89 (manuscript received 11 Jul 88 pp 550-552, 549

[Article by Tan Guanrong [6223 0385 2837], Yang Wenxia [2799 2499 7209], Guo Mingxia [6753 2494 7209] and Sui Yan [7131 3601] of the Department of Electronic Science, Nankai University, Tianjin; and by Fu Rulian [0265 3067 1670] and Kai Guiyun [7030 2710 7189] of the Modern Optics Institute, Nankai University]

[Abstract] Doppler-free laser opto-acoustical spectrographs made an advent in the late seventies; these spectrographs have very high sensitivity and ability to discriminate fine structure at the molecular or atomic energy level. In contrast to the conventional laser opto-acoustical spectrographs, the Doppler-free laser opto-acoustical spectrograph uses a triple chopper, not a single channel chopper, for chopping the laser beam. This project presents the structure of a triple chopper and its function in detecting Doppler-free laser opto-acoustical signals. The discussion includes how to select the hole number ratio of the chopping holes in order to reduce interference due to combination frequencies, and how to enhance the signal-to-noise ratio of Doppler-free laser opto-acoustical signals. Experimental results are given. Four figures show the structure of a triple chopper, chopping blades, an experimental arrangement, and spectral lines of Doppler-free laser opto-acoustical signals for different chopping number ratios. One table lists data for different combination forms of combination frequencies. The research was supported by (China's) State Natural Science Fund.

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**Development of Organic Nonlinear Optical Crystal POM**

906A0001E *Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS]* in Chinese Vol 16 No 9, 20 Sep 89 (manuscript received 30 Aug 88) pp 560-563

[Article by Li Songxian [2621 1345 6343], Chen Jianzhong [7115 1696 0022], Dong Meibin [55165019 2430] and Wang Jiahe [3769 1367 0735] of the Department of Chemistry, Fuzhou University; and Wu Bochang [0702 2672 2490] of the Fujian Institute of Material Structure, Chinese Academy of Sciences]

[Abstract] The paper explores the conditions for synthesizing POM (3-methyl-4-nitropyridine-1-oxygen), the growth conditions of POM monocrystals, sieving selection of solvent, determination of metastable region, control of temperature drop, determination of linear optical properties, theoretical computation and verification of phase matching, as well as the determination of the frequency-doubling coefficient and its conversion efficiency, among other subjects. The light-transmission curve of a monocrystal is plotted; the threshold value of light damage is determined. The category I and II phase-matching curved surface loci of POM monocrystals are computed. Experimental results are given for verification. Five figures show the appearance of a POM

crystal, solubility and its supercooling curve, POM transmission curve, as well as category I and II phase-matching angle and the effective nonlinear coefficient of POM. Two tables list data of the category I phase-matching angle of POM, and light-damage threshold value of a POM crystal. The authors are grateful to senior engineer Yang Xiangchun [2799 7449 2504] of the Shanghai Institute of Optics and Fine Mechanics, Professor Xie Shengwu [6200 4939 3976] of Shanghai Jiaotong University, and Huang Gongfan [7806 6501 3131] of the Fujian Institute of Material Structure for their assistance.

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**Two New GaAs Very-High-Speed Integrated Circuits Developed**

40080004a

[Editorial Report] Shanghai WEN HUI BAO in Chinese on 24 October 1989 carries on page 1 a 300-word article on the development of two new gallium arsenide (GaAs) very-high-speed integrated circuits (VHSIC's)—a GaAs high-speed frequency divider and a 120-gate GaAs gate-array device—by the Chinese Academy of Sciences' (CAS) Shanghai Institute of Metallurgy. The latter IC contains 876 elements on a 1.7mm x 1.4mm chip. Additional details not provided in an earlier report (see FBIS-CHI-89-214, 7 Nov 89, p 23) follow. These two

medium-scale-integration (MSI) IC's, which have recently passed the technical appraisal sponsored by the CAS, have wide applications in high-speed electronic systems used in supercomputers, high-capacity fiber-optic and digital microwave communications, aerospace technology, radar, and electronic countermeasures. One reason is the low power consumption; each gate-array chip consumes only 5 milliwatts. By organizing the talent of several laboratories, the institute—which was China's first institute to develop (in the 1960's) microelectronic integrated circuits—was able to complete the project a year ahead of schedule, and thus to break the monopoly held by Western nations on these devices.

**Scientists Create New Superconducting Film**

40100008 Beijing XINHUA Domestic Service  
in Chinese 0602 GMT 9 Nov 89

[By reporter Zhang Xuejin]

[Text] Shanghai, 9 Nov (XINHUA)—Chinese scientists have made further significant progress in superconductor research. Recently, they have successfully created a superconducting film with a zero-resistance temperature of 90.5 K by using a one-step film-forming technique with an organo-metallic chemical vapor-phase deposition (OMCVD) method. This achievement has set a new world record.

The OMCVD method is a new technique of using organo-metallic compounds to form a film in one step by the chemical vapor phase sedimentation process. Before this, Japan's Tohoku University used the same technique and made a superconducting film, which had a highest zero-resistance temperature of 89 K.

In the international competition in superconductor research, most scientists in recent years have devoted their efforts to the development of superconducting films by using the direct-current magnetron sputtering technique. Yet, this method can only be applied to rather large objects. The characteristic advantage of the one-step film-forming OMCVD technique is that it requires only simple equipment and is suitable for the production processes of electronic parts and devices. In particular, this technique makes it possible to form superconducting films on objects of complicated shapes such as wires and straps. This will help overcome the difficulty in processing caused by the fragility of ceramic superconductors.

The success in making the superconducting film by the one-step film-forming technique is a result of cooperation between the Shanghai Metallurgy Institute of the

Chinese Academy of Sciences and the Shanghai Organic Chemical Research Institute. Their superconducting film not only has a zero-resistance temperature of 90.5 K, but also can reach a current density of 16,000 amperes per square centimeter at its transitional temperature of 77 K, close to the advanced world standard.

**Superconducting Material With Transition Temperature of 100 K Developed**

40080004B Beijing ZHONGGUO DIANZI BAO  
in Chinese 10 Oct 89 p 3

Article by Tan Guoping [6151 0948 1627]]

[Text] After repeated experiments using a Pb-doping technique, the superconductor group of Institute 16 under the Ministry of Machine-Building & Electronics Industry has announced its recent development of a Bi-Pb-Sr-Ca-Cu-O-based superconductor with a transition temperature (zero-resistance temperature) of over 100K. Its maximum transition temperature has reached 104K.

Following upon the Y-Ba-Cu-oxide (YBCO) series of superconductors, other series of superconductors with a high  $T_c$  [critical temperature], such as the Bi-Sr-Ca-O non-rare-earth series, have been discovered. The new material developed by the superconductor group uses  $\text{Bi}_2\text{O}_3$ ,  $\text{PbO}$ ,  $\text{SrCO}_3$ ,  $\text{CaCO}_3$ , and  $\text{CuO}$ , ground in appropriate proportions to an even consistency, preheated at 800°C, then finely ground again, and, after shaping, sintered at 855°C with strict standards maintained to prevent the temperature from falling. Through repeated experimentation and testing, the technique for preparing this Bi-Pb-Sr-Ca-Cu-O superconductor has proven stable and reliable, with good repeatability. The samples prepared have been subjected to applied research, and it is anticipated that weakly connected devices can be developed with working temperatures higher than those of the YBCO series.

## Developments in Fiber-Optic Communications Reported

### 34 Mbps Optical Terminal, Other Products Certified

90CF0080 Beijing ZHONGGUO DIANZI BAO in Chinese 19 Sep 89 p 3

[Article by Zhou Zhiqiang [0719 1807 1730] and Wen Tingmu [2429 1656 3668]]

[Text] The Chongqing Communications Equipment Plant under the Ministry of Posts and Telecommunications recently developed and began manufacturing five new products, including a DS3 [34 Mbps] optical terminal, optical repeater, optical fixed attenuator, PCM DS0 [under 2 Mbps] terminal and data terminal, by collaborating with outside research organizations. It is an encouraging step in our effort to speed up the commercialization and manufacturing of high technology.

Experts involved in the certification of these products confirmed that the electric characteristics of these products meet CCITT (Consultative Committee on International Telegraphy and Telephony) standards and that they are ready for production. The major specifications of two optical communications devices have reached the level of similar products manufactured abroad in the mid-1980's. This is a significant step in the development of digital communications in China.

Because of a late start, there is an 8-10-year gap between China and other leading countries in optical communications. The gap is especially large in the commercialization and manufacturing of technical achievements. In order to meet the needs of communications, the plant took a bold step in working with research institutes to develop a series of new products by utilizing its own strength. The certified 34 Mbps optical terminal and optical repeater were re-designed based on original research effort to meet technical and structural requirements in batch production. They use the internationally popular long narrow frame design and are a success. The PCM [pulse code modulation] DS0 terminal and data terminal equipment are digital multiplexing devices. With a single-channel time slot, it can accommodate 120 teletypes and 5 facsimile machines simultaneously to greatly increase its capacity. It took the factory only a year to convert the research achievements into products and to begin batch production of goods worth over 300,000 yuan.

### Fiber-Optic, Laser, Microelectronics Products From Wuhan

90CF0080 Beijing ZHONGGUO DIANZI BAO in Chinese 22 Sep 89 p 3

[Article by Dai Yinian [2071 0110 1628]]

[Text] The Wuhan Donghu New Technology Development Zone (hereafter simply "development zone") was recently approved as a key national development zone.

In terms of concentration of intelligence and technology, it is next only to the Zhongguancun in Beijing. Since large-scale development began to take place in 1988, under the guidance of "limiting our objectives, focusing on key points, and using basic projects to stimulate development," microelectronics, lasers, and fiber-optic communications have been identified as priority areas. Products and prototypes are being built in these areas. In microelectronics and laser technology, a series of new products is being produced. Some research achievements have been converted into products and production on a fixed scale has begun. In particular, a technical team capable of providing a complete set of fiber-optic communications equipment has been formed, including a number of companies involved in the development of fiber-optic communications and construction teams. A pilot plant capable of producing 8,000 kilometers of fiber per year is in operation. A Chinese-Dutch joint-venture optical fiber and cable plant with an annual capacity of 50,000 kilometers of fiber and 6,000 kilometers of cable is currently under construction. In addition, a trans-regional inter-departmental entity, the Changjiang Communications Group, has been established.

Among the priority projects to be promoted, the development zone must not rely on government support alone. It must carry out the development, accumulate experience and perfect the product on its own as guided by the policy. In addition, the development zone should actively explore the possibility of commercializing research achievements such as using new technology to help turn a losing business around.

### Shandong Province To Build Fiber-Optic Network

90CF0080 Beijing ZHONGGUO DIANZI BAO in Chinese 29 Sep 89 p 1

[Article by Xing You [2450 1429]]

[Text] The Provincial Government of Shandong recently decided to build a state-of-the-art fiber-optic communications network in two stages over the next 4 years. This project requires approximately 240,000,000 yuan. The entire province needs a total of 5,000 kilometers of optical cable. The province is responsible for the installation of fibers between cities and localities, and cities and localities are responsible for the installation of fibers going to counties and towns.

### Report on Fourth National Fiber-Optic Communications Conference

90CF0080 Beijing RENMIN RIBAO [PEOPLE'S DAILY] (Overseas Edition) in Chinese 12 Oct 89 p 4

[Article by Feng Yizhen [7458 0076 3791]]

[Text] Shanghai, 11 Oct 89 (XINHUA)—The fiber-optic communications industry in China has entered a practical stage since it began in the early 1970's.

The author learned from the Fourth National Fiber-Optic Communications Conference currently in progress

in Shanghai that optical fiber and cable, optical devices, optical terminals and other ancillary equipment are already in production. A complete industry is essentially in place. The entire country has installed and is planning to install a total of 11,400 kilometers of optical cable. The 2,400 kilometer Ning-Han-Yu (Nanjing to Wuhan to Chongqing) fiber-optic project will be completed in 1990. The 252-kilometer section from Hanyang to Jingzhou was built with domestic fiber and equipment and is already in operation. Most of the 15 demonstration projects in applications such as long-distance trunk lines, urban relay stations, railroad communications, broadcasting and television, electric-utility communications, and traffic monitoring are completed and put in operation satisfactorily. A number of fiber-optic communications projects are also in operation at Shanghai, Beijing, Wuhan, Guilin and Guangzhou.

Experts predict that China will have a large-scale optical communications industry by 1990. Shanghai, Tianjin and Wuhan will become three major bases with a total capacity of 100,000 kilometers of fiber and 10,000 kilometers of cable per year. In the meantime, progress will also be made in the research and production of fiber, cable, equipment and devices, and research, production and application of optical communications will be consolidated. Fiber-optic communications will enter a practical stage from the research and experimental phase, and efforts are under way to promote the fiber-optic communications industry toward the leading edge of this technology. Three years ago, we could only produce the third-generation multi-mode long-wavelength fiber. Now, we can make the fourth-generation single-mode DS4 (140 Mbps) fiber. We have successfully developed a single-mode DS4 fiber-optic communications system. There are 1,920 channels in a pair of fibers, which is three times that in the DS3 multi-mode fiber-optic communications system. Only a few countries in the world can make dynamic single-longitudinal-mode lasers, long-wavelength avalanche photodiodes and single-mode pigtail luminescent diodes, all of which have

been successfully developed domestically and are already in production. We are also making breakthroughs in the latest technology in fiber-optic communications—local area fiber-optic networks [LAN's] and office automation.

China's fiber-optic communications industry is also making rapid progress in technical collaboration with its foreign counterparts. In recent years, an optical-terminal production line was imported from Italy. An optical device company was established with American capital. In addition, manufacturing technology and equipment have been imported to produce devices in order to improve the quality of domestically manufactured optical terminal systems and devices.

#### Multiple-Structure Single-Core-Capable Fiber-Optic Network System Developed

40080004C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 40, 18 Oct 89 p 1

[Article by Yuan Yulun [5913 6661 0243] and Deng Xianchun [6772 6343 2504]]

[Summary] A multiple-structure single-core-capable fiber-optic 3+ network system, jointly developed by the University of Electronic Science & Technology [formerly Chengdu Institute of Telecommunications Engineering] and by Chengdu Hualian [5478 5114] Electronics Ltd., passed technical accreditation in Chengdu on 5 September. This system, applicable to business computer networking, especially in the electric power, chemical engineering, petroleum, electric transportation, railroad transport, military, and public security fields, has been evaluated as state-of-the-art domestically, and meets 1980's international standards. The system's unrepeatable transmission range is 4.5 kilometers, and its cost is only one-third to one-fourth that of the original coaxial cable 3+ computer network system. The system provides transmission of the computer star, ring, and hybrid forms. The system provides transmission of the computer data signals in two directions with a single-core fiber-optic cable.